



***CE Workgroup***

# **Status of Embedded Linux**

**December 2011 update**

Tim Bird

Architecture Group Chair

LF CE Workgroup



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# Outline

Kernel Versions  
Technology Areas  
CE Workgroup Projects  
Other Stuff  
Resources



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# Outline

Kernel Versions

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# Kernel Versions

- Linux v2.6.37 – 4 Jan 2011
- Linux v2.6.38 – 14 Mar 2011 – 69 days
- Linux v2.6.39 – 19 May 2011 – 66 days
- Linux v3.0 – 21 July 2011 – 63 days
- Linux v3.1 – 24 Oct 2011 – 95 days
- Linux v3.2-rc4 – ???
  - *My prediction – 3 Jan 2012*



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# Linux v3.0

- Fast symbol resolution for module loading
  - Binary search instead of linear lookup for module linking
- POSIX alarm timers
  - Similar to Android Alarm Timers
  - See <http://lwn.net/Articles/429935/>
- BKL function calls are now gone
- ARM arch tree refactoring
  - See Arnd Bergmann's presentation from ELC Europe – “News from the ARM Architecture”





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# Linux v3.1

- Watchdog timer core
- New framework for handling power management domains was added
  - See `driver/base/power/domain.c`
- Multiple ARM SoCs now have device tree support



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# Linux v3.2 (probable)

- New pin control subsystem
  - Allows control of multiple pins as named groups, with multiplexing
  - See Documentation/pinctrl.txt
- devfreq – DVFS for non-cpu devices
- PM QOS now supports per-device constraints
  - See Documentation/power/pm\_qos\_interface.txt
  - See <http://lwn.net/Articles/466230>



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# Things to watch

- ARM arch sub-tree refactoring
  - <http://lwn.net/Articles/443510/>
- Device trees
- More runtime PM improvements
- Android features
  - More on this later
- Boot timing patches
  - Patches to add set printks to kernel and bootloader at particular milestones in boot
  - See <http://lkml.org/lkml/2011/9/23/348>





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CE Workgroup Projects

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# Bootup Time

- Filesystem speedups
  - CELF funding work in this area (more later)
- Angstrom experiment with systemd
  - Koen Koi's talk at ELC Europe – Integrating systemd: Booting Userspace in Less than 1 second
  - Systemd uses interesting event-based startup and asynchronous coupling between systems
  - Was nice to see Lennart Poettering there learning about embedded requirements
  - Embedded system startups are increasing complex



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# Graphics

- Big issue in graphics is memory management
  - /dev/ion -- a unified approach to buffer management and sharing between display, GPU, camera, codecs, etc, new in Ice Cream Sandwich
- Accelerated rendering is also a big topic
  - Especially important for larger screens (tablets and TVs)
  - Google has new renderscript technology
    - Uses LLVM (on-target compiler) to do runtime retargeting of script to whatever capabilities device has



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# File Systems

- Google moving to Ext4 for future Android devices
  - Already using eMMC instead of raw flash
  - Sad to see proprietary algorithms in black boxes responsible for storage performance
    - Lots of MMC optimized for serial workloads and FAT filesystems
- Want to optimize Linux block filesystem layers for flash
  - See Arnd Bergmann's talk at ELCE on filesystem performance on cheap flash media





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# Power Management

- Device power domains
  - Set of devices sharing power resources (clocks, power planes, etc.)
  - See Rafael Wysocki's talks at LinuxCon Japan 2011 and ELC Europe 2011
- Device frequency scaling
- Many talks about power management at ELC Europe
  - Avinash Mahadeva – SOC Power Management – Debugging and Optimization Techniques





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# System Size

- Can tune system pretty well using existing configuration options
  - See Darren Hart's ELC Europe presentation: Tuning Linux for Embedded Systems: When Less is More
    - Achieved a system running comfortably in 8 MB with not a huge effort
    - Is folding results into Yocto - poky-tiny distribution
- 4K stacks for ARM
  - Submitted by me, but rejected
  - Could have been accepted, but I need to incorporate feedback
  - See [http://elinux.org/Small\\_Kernel\\_Stacks](http://elinux.org/Small_Kernel_Stacks)



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# Tracing

- Ftrace and Perf still going strong
  - KernelShark gui for ftrace
  - Pytimechart – new visualization tool for ftrace and perf data
    - See Pierre Tardy's slides from ELC Europe (very good tutorial on hunting down wakeup issues)
- LTTng 2.0 has been released
  - See Matthiue Desnoyer's presentation at LinuxCon Europe: "LTTng 2.0: Application, Library and Kernel tracing within your Linux Distribution"
  - Now LTTng is a loadable kernel module (no patches required)
  - Common Trace Format (mentioned later)



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# CEWG Contract Work 2010

- Bootchart and smemcap in busybox
- Function-sections
- YAFFS2 mainline effort
- SquashFS enhancements
- U-Boot ARM enhancements
- **Trace format standard**
- Kexecboot enhancements
- Flash filesystem testing



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# Trace Format Standard

- Create a single trace format standard for the embedded industry (CTF – Common Trace Format)
  - See <http://www.efficios.com/ctf>
  - Allows reuse of tools with data from different tracing systems
- BabelTrace trace conversion library
  - Converts trace formats into CTF
  - Proof of concept conversion implementation
    - Can convert kernel messages with timestamps to CTF and back to text

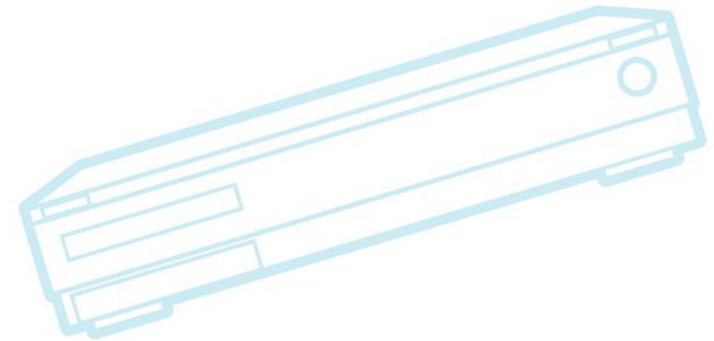
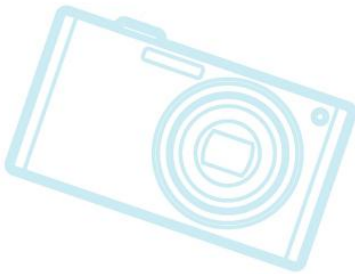




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# CEWG Contract Work 2011

- Mainline fast symbol resolution
- Mainline Device Firmware Upgrade (DFU) code in U-Boot
- Work on Linux tiny patches
- Improve UBIFS mount time
- Flash filesystem testing





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# Contract Work 2011 (cont.)

- Mainline the watchdog framework
- Extend bluetooth stack with Remote SIM Access protocol
- Kernel trace and debug documentation (on eLinux wiki)
- Mainline Android kernel features



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# Contract Work Details

- Mainline fast symbol resolution
  - Change symbol lookup to use binary search instead of linear scan to speed up module loading
  - Already mainlined (Linux v3.0)
- Mainline DFU code in U-Boot
  - Device Firmware Upgrade (DFU) is an industry standard for upgrading and manipulating firmware in embedded devices
- Work on Linux tiny patches
  - Revive Linux-tiny patch set
  - Forward-port patches to latest kernel
  - Add more patches to improve kernel configurability



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# Contract Work Details (2)

- Improve UBIFS mount time
  - Add logging or checkpointing to UBI to avoid bad-block scan of whole device on UBI attach
- Flash filesystem testing
  - Publish performance results for each new kernel version
  - Lots of great data – charts and graphs!
  - Check out:  
[http://elinux.org/Flash\\_Filesystem\\_Benchmarks](http://elinux.org/Flash_Filesystem_Benchmarks)



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# Contract Work Details (3)

- Mainline the watchdog framework
  - Provides a generalized watchdog mechanism
    - Should provide easier method to add watchdogging to drivers and the kernel going forward
  - Original framework was written by Alan Cox and others
- Extend bluetooth stack with Remote SIM Access protocol
  - Allows for Linux bluetooth and telephony stack to utilize SIM in external device for operation
  - Primary use is for Linux-based in-car system to utilize SIM in mobile device for telephony





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# Contract Work Details (4)

- Mainline Android kernel features
  - Goal is to incrementally reduce diff between Android and mainline kernels
  - Have CE Workgroup funding approval to do a pilot project to mainline Android logger code
    - If successful, will try other pieces
  - Almost finished creating broken-out patch set for android-common (diff against 3.0)
    - Linaro developer also has patches isolated into topic branches in stgit
  - Given recent input at kernel summit, I plan to broaden the scope of this project
  - If you are interested in this – email me!



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# Long Term Support Kernel for Industry

- CE Workgroup is initiating a new project for companies to collaborate on maintaining a kernel version for embedded products
  - Similar to long-term kernel maintained in enterprise space
  - Based on community long-term tree
- See presentation later today by Munakata-san



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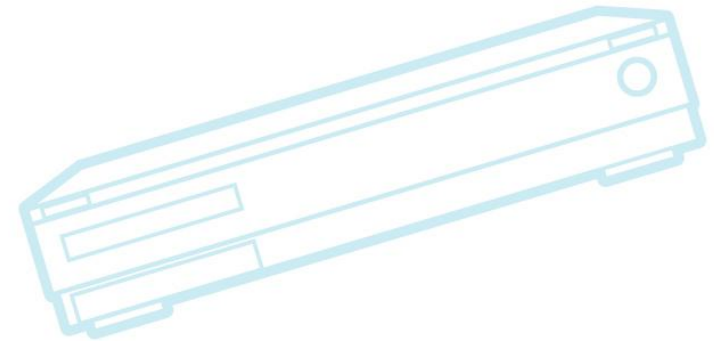
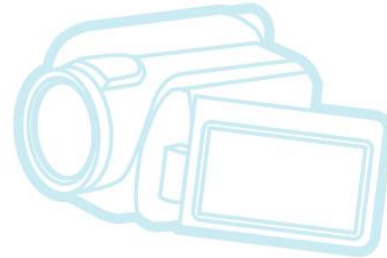
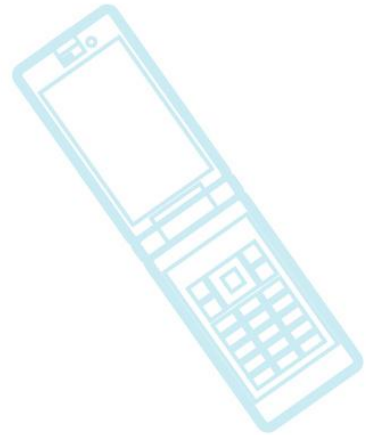
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# Other Stuff

- Tools
- Build Systems
- Distributions
- Android
- Industry Organizations
- Community Infrastructure
- eLinux wiki
- Events





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# Embedded Distributions

- Tizen = MeeGo + Limo + (WAC technologies)
  - Was announced a few months ago
  - Nokia switching to Windows Mobile
  - Focus = HTML5 applications
  - <http://www.tizen.org/>
- Angstrom/Poky (Yocto) are closest thing to an industry standard (non-vendor-specific) generic embedded distribution
- Linaro doing lots of images (Android, Ubuntu, etc.)
- Lots of custom embedded





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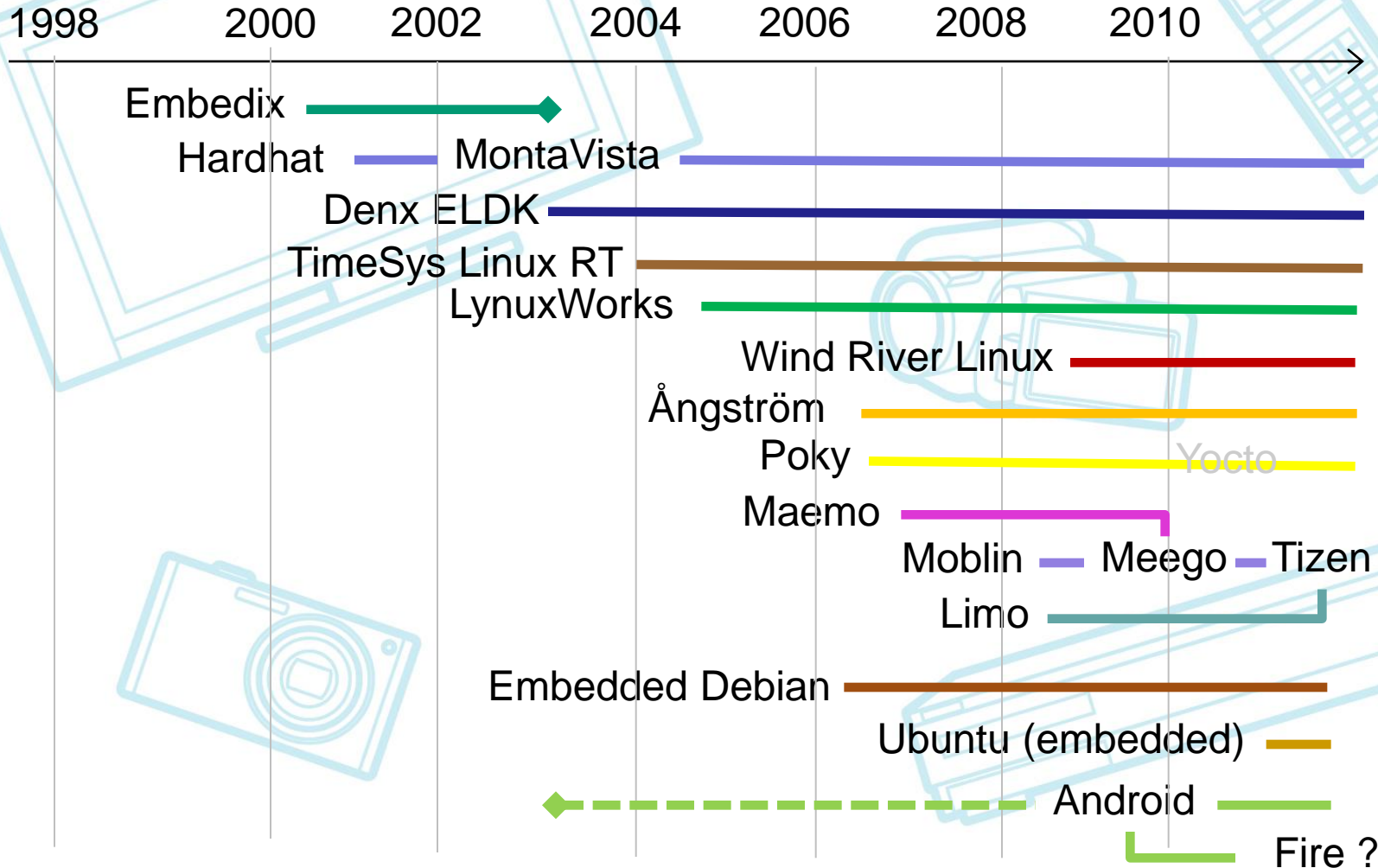
# Android

- Android 4.0 (Ice Cream Sandwich) released October 2011
- Ice Cream Sandwich unifies mobile, tablet and TV platforms in one codebase
- Phone activations at least 550,000 per day
  - That was June – probably a lot more now
- Dalvik ported to non-Android
  - Myriad Alien Dalvik for Meego
  - IcedRobot for native Linux
  - OpenMobile's ACL (Application Compatibility Layer)



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# Distributions





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# Industry organizations

- Linaro
  - Doing lots of great stuff
  - See David Rusling's ELC 2011 talk
- Linux Foundation
  - Has lots of embedded-related projects
    - Yocto, Meego, CE Workgroup
- CELF merged with LF
  - CELF is now the LF "CE Workgroup"
  - Now utilizing LF infrastructure
    - Should mean it's easier for public to participate in CE WG initiatives
      - Except for when it's out of commission



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# Community infrastructure

- Kernel.org hacked in November 2010
  - Credential-stealing code was installed and running for 9 months
  - Not a Linux-targeted attack, part of a more widespread attack
- Git was really useful:
  - To validate integrity of kernel sources (although they were not a target)
  - To continue uninterrupted operation
- Linux Foundation servers were very likely compromised due to the kernel.org breakin





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# Community infrastructure (cont.)

- It's been a rough few months with stuff offline
- Most things restored
  - CELF/CE WG mailing lists are back online
  - Look for increased activity leading up to ELC
- Want to increase use of mailing list (celinux-dev) and wiki (elinux)
  - Plan some survey questions
  - Want to see more content creation on wiki based on company research projects





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# eLinux wiki - <http://elinux.org>

- Recent articles of interest:
  - [http://elinux.org/Kernel\\_Small\\_Stacks](http://elinux.org/Kernel_Small_Stacks)
    - OK – it's my recent pet project
  - <http://elinux.org/Toolbox>
    - Major layout reorganization
  - <http://elinux.org/KDB>
- Pages for specific hardware:
  - RaspberryPI, Panda, BeagleBoard
- Fun to follow:
  - <http://elinux.org/Category:ECE497>
    - CS course on embedded Linux



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# Past Events

- Kernel Summit
  - October 23-25 in Prague, Czech Republic
- Embedded Linux Conference Europe 2012
  - October 26-28 also in Prague
- Prague in October became a “super-event”
  - Real-time Linux workshop
  - ARM maintainers summit
  - Gstreamer conference



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# Kernel Summit surprise

- Android
  - Android was not on the agenda
  - I was gearing up for a big fight over mainlining Android features
  - Ingo Molnar, Ted Tso, Linus Torvalds, Paul McKenny and others advocated re-examining the Android patches
  - Someone still needs to submit them (Google is in no mood)
- We need to keep fighting bloat
  - New logging system proposed which added minimal overhead of 16 bytes per message!!



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# ELC Europe 2011

- Lots of very good talks
  - See [http://elinux.org/ELCE\\_2011\\_Presentations](http://elinux.org/ELCE_2011_Presentations)
  - Complain to me if you can't find slides for a talk you are interested in
  - Videos are already online!!
    - Thanks Free Electrons
- A few of my personal favorites
  - Matt Jones keynote about Linux in Automotive
  - Jonathan Corbet's keynote retrospective
  - Darren Hart's talk on size reduction
  - Pierre Tardy's pytimechart talk
  - Closing game was very funny





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# ELC Europe 2011

- I had a really good time at this event
- Maybe something about being combined with kernel summit and LinuxCon
- My impressions
  - Developers (non-embedded) are receptive to needs of embedded products
  - Nice to be part of a wider community
    - Its good to meet other developers with similar problems
    - Nice to see different solutions
  - Good worldwide attendance
- Definitely a fun industry with interesting problems and products





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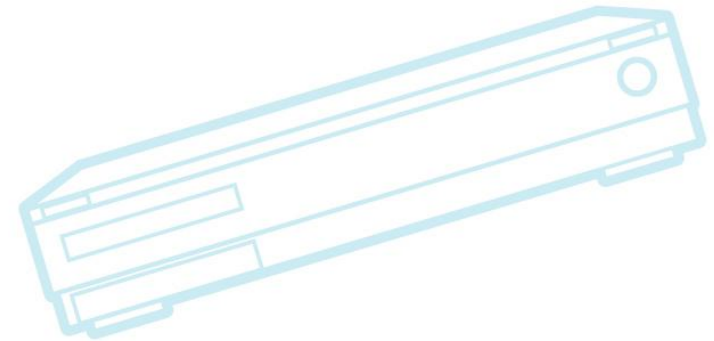
# Future Events

- Android Builders Summit 2012
  - February 13-14, Redwood Shores, California
- Embedded Linux Conference 2012
  - February 15-17, Redwood Shores
- Call for papers for ABS & ELC are out now
  - Deadlines are soon (Dec 31 and Jan 7)
  - Wouldn't mind seeing talks from ELCE again!
- LinuxCon Japan 2012
  - June 6-8, Yokohama, Japan
- Embedded Linux Conference Europe 2012
  - November 7-9, Barcelona, Spain



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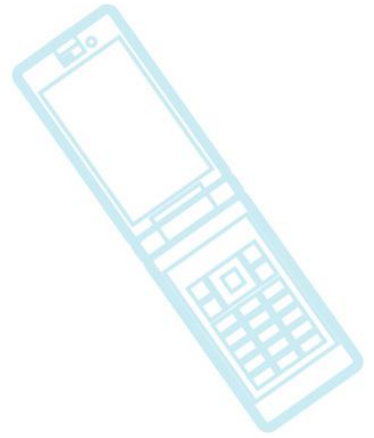
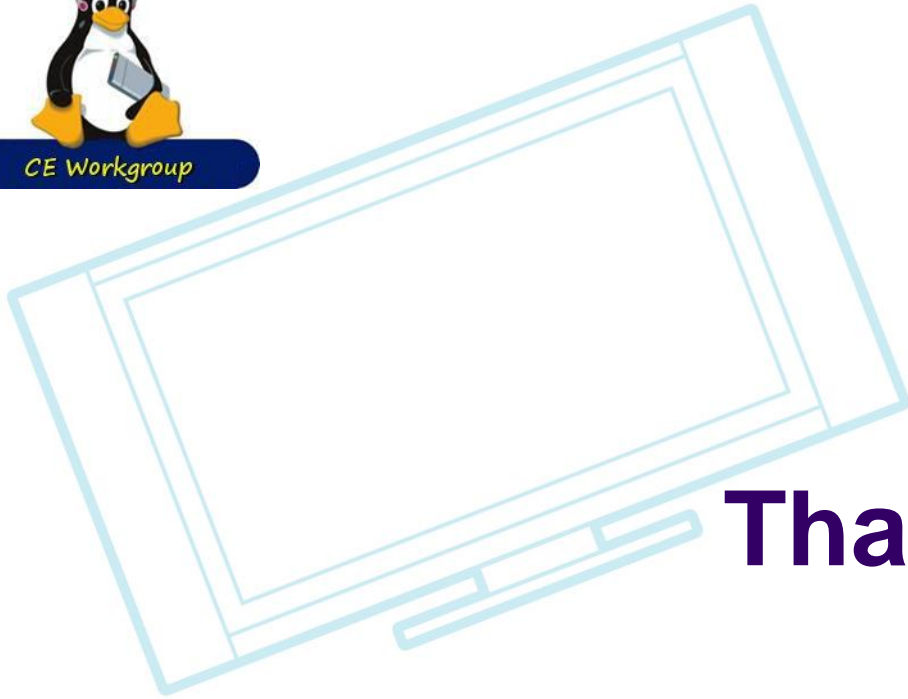
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# Resources

- LWN.net
  - <http://lwn.net/>
  - If you are not subscribed, please do so
- eLinux wiki - <http://elinux.org/>
  - Especially <http://elinux.org/Events> for slides
- Linux-embedded mailing list
  - <http://vger.kernel.org/vger-lists.html#linux-embedded>
- CELinux-dev mailing list
  - <http://lists.celinuxforum.org/mailman/listinfo/celinux-dev>



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**Thanks!**

